

Product-Category Rules (PCR)
for preparing an environmental product
declaration (EPD) for
Optoelectronic semiconductor

PCR 2010:1.0

LiteOn Technology Corporation

Environment and Development Foundation

Version 1.0

2010-10-15

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1. General Information

This document is to be used as the product category rules (PCR) for optoelectronic semiconductor. The requirements specified in this PCR are intended to be used for EPDs certified in accordance with ISO 14025 standard. This document shall be valid until October 15, 2012

This PCR was prepared by LiteOn Technology Corporation and Environment and Development Foundation. Representatives from major Taiwanese manufacturers of similar products and stakeholders were invited by Taiwan Electrical and Electronic Manufacturers Association (TEEMA) and Taiwan Optoelectronic semiconductor Industry Association (TOSIA) to the open consultation meeting on August 15, 2010, to participate in the discussion and review of this PCR. EDF then reviewed and approved this PCR. The C.C.C. Code for the product defined in this PCR is 8541.

For further information and processing of feedback comments concerning this PCR, please contact: Mr. Jeffrey Su, DQA Dept., Global Operations, Optoelectronics SBG, Lite-on Technology Corp., (tel : 886-2-2222-6181 ext : 2133 · fax : 886-2-2221-2780 ; email : jeffrey.su@liteon.com) ◦

2. Company and product description

The EPD shall include information about the manufacturing company/organization. The information may include manufacturing process related information, and environmental related information, such as the environmental management system information. The information may also include special issues which the company/organization would like to emphasize, such as the products meeting certain environmental criteria, or environmental safety and health related information.

This PCR covers the optoelectronic semiconductor and is applicable to communications from business to business (B2B). The optoelectronic semiconductor products covered in this PCR include their packaging, but exclude solar photovoltaic batteries, charge-coupled devices (CCD), and contact image sensors (CIS).

2.1 Product function

The optoelectronic semiconductor is a special kind of semiconductor capable of conversion between electricity and light. Based on their applications, optoelectronic semiconductors can be divided into light emitting components, light receiving components and integrated light-emitting/light receiving components. Light emitting components can emit light covering the wavelength of ultraviolet, visible light or

infrared when electricity current or voltage is applied; light receiving components can convert the incident light into electricity; while integrated components combine the functions of both light emitting and light receiving components. Optoelectronic semiconductors are widely used in the fields of direction, lighting, communications and detection etc., with major applications including computer and peripheral, office automation products, consumer electronics, communications, automotive, industrial, military, aerospace, medical and other markets.

2.2 Product components

The basic components of the optoelectronic semiconductor shall at least include the chip/die, and the following packaging materials:

- (1) Adhesive: Silver paste, epoxy, silicone etc.
- (2) Carrier Substrate: Lead-frame (Cu/Fe), substrate (organic/ceramic, tapes, etc.
- (3) Electrical Connection: Metal wire (Au), solder bump, solder ball, Cu pillar, Au bump, etc.
- (4) Optical Encapsulant: Molding compound, liquid compound, glass lens, etc.
- (5) Heat Dissipation: Heat sink/slug/spreader, TIM (thermal interface material), etc.
- (6) Packaging: bag, tape & reel, tray, tube, carrier, box, and other packing materials.
- (7) Others: Ink, powder (Phosphor/SiO₂), zener, resistor, capacitor, etc.

2.3 Product technical description

The product technical description part of the EPD shall **at least** include the following information:

- (1) Package Name
- (2) Package Dimensions: L (mm)*W (mm)*H (mm) + Key Dimensions
- (3) Absolute Maximum Ratings
- (4) Electro-Optical Characteristics
- (5) User Guide
- (6) Cautions
- (7) Designed life span

The product's electronic and optical characteristics shall be measured based on the standard testing methods as stipulated by the International Electrotechnical Commission (IEC) and International Commission on Illumination (CIE). The adopted test methods shall be described.

3. List of materials and chemical substances

The contents of the following materials and chemical substances in the product shall be declared:

- All materials used in the product weighing $\geq 1\%$ product weight;
- All banned substances regulated and environmentally-related by legal and customer requirements. (such as compliance declaration required in EU's RoHS Directive).

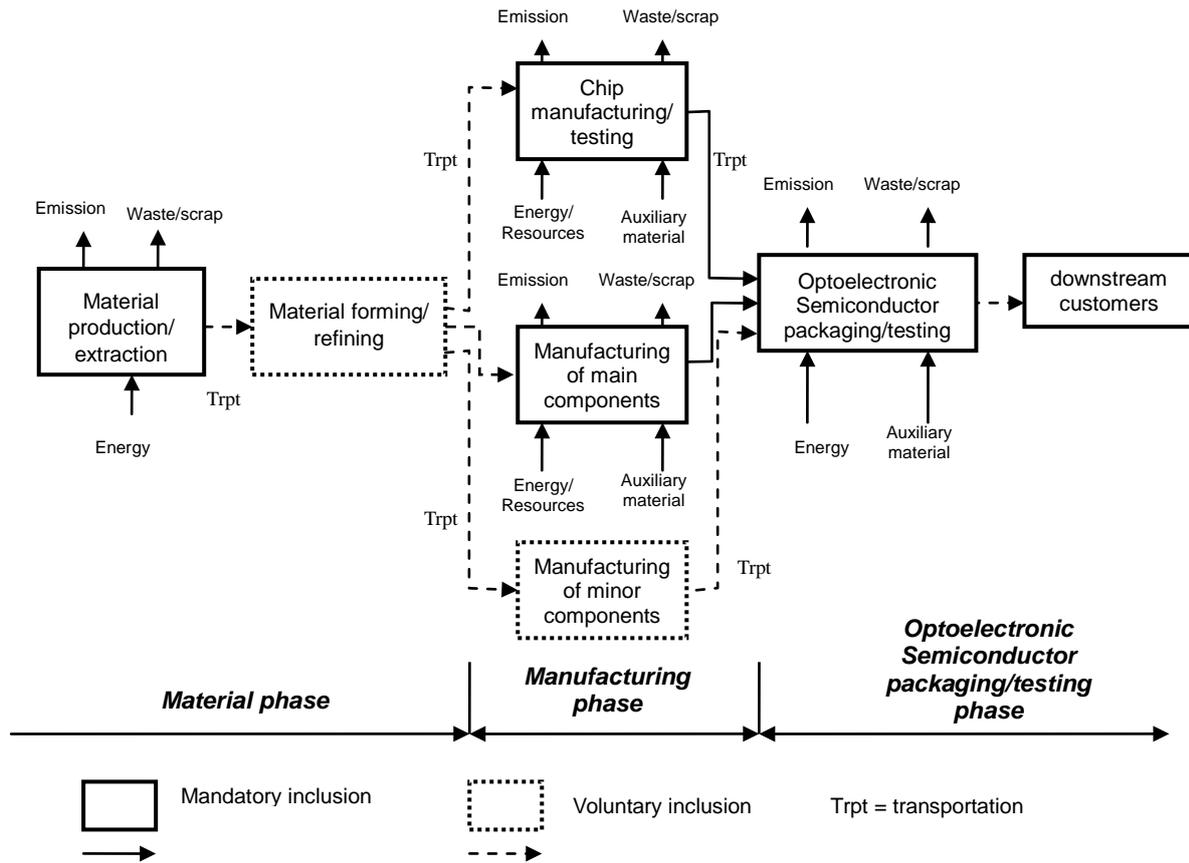
The declaration of halogen-free flame retardants, lead-free solders and no RoHS-regulated substances may only be made when appropriate evidences are available (for example, test reports from accredited laboratories/testing facilities). The following organizations may provide accreditation for testing facilities: Taiwan Accreditation Foundation (TAF), (Asia Pacific Laboratory Accreditation Cooperation (APLAC), International Laboratory Accreditation Cooperation (ILAC) or ILAC Mutual Recognition Arrangement (ILAC MRA). For definitions of testing methodology and confirmations of regulated hazardous substances based on the accredited laboratories' product testing methods, please refer to IEC 62321 Standard.

4. Declared unit

The declared unit is defined as one package/piece of optoelectronic semiconductor, as optoelectronic semiconductors are marketed and sold in such units.

5. System boundaries

The main system boundaries of the product system are B2B in nature and presented as follows:



Notes

1. The materials mean except chip/die, the packaging materials which will remain on the product. Main materials are materials weighing over 1% product weight, while secondary materials are materials weighing less than 1% of product weight.
2. Auxiliary materials are materials which are used during the manufacturing process but do not remain on the product.
3. Calculation of product packaging materials shall be based on actual consumption.

Figure 1 System boundary of the main product system

The life cycle of an optoelectronic semiconductor is described in Figure 1 above. The inclusion in the LCA information on recycling is voluntary (see Section 11).

The LCA shall include information for the following unit processes:

Raw material acquisition phase

- Material extraction

Manufacturing Phase

The LCA shall include information for the following unit processes:

- Manufacturing of chip/die and main materials
- Transportation of chip/die and main materials

Optoelectronic Semiconductor Packaging and Testing Phase

- Optoelectronic Semiconductor Packaging and Testing

The inclusion in the LCA the information on the raw material forming and refining and manufacturing of auxiliary materials is of the voluntary reporting nature. When voluntarily reported information is included, they shall be explained in the EPD.

5.1 Specification of different boundary settings

Boundary in time

The validity period for the LCA results presented in the LCA report shall be defined.

Boundary towards nature

If the manufacturing processes are located within Taiwan, the waste categories as defined in Taiwan's Waste Disposal Act shall be adopted. If the processes are located in other countries, equivalent legal requirements shall be considered.

The natural boundary of the system shall describe the boundary where the materials and energy resources flow from nature into the system, and where the water and air emissions and waste are released out of the system.

Only waste which is required to be disposed of needs to be considered. If the waste will be treated through water treatment or incineration, these processes need to be included; landfilling process does not need to be included.

Boundaries in the life cycle

The boundaries in the product life cycle are described in Figure 1. The construction of the site and infrastructure, as well as the production of manufacturing equipment and activities of the workers, does not need to be included.

Boundaries towards other technical systems

Boundaries towards other technical systems describe the inputs of material and other components towards other systems, as well as outputs of materials towards other systems. For the inputs of recycled materials and energy towards the product manufacturing phase, the transportation between the recycling process and use of recycled materials shall be included in the data set. For the production of recyclable products during the manufacturing phase, the transportation towards the recycling process shall be included.

(Note: Further explanations are provided in Section 7 on open-loop recycling)

Boundaries regarding geographical coverage

The manufacturing phase may cover manufacturing processes located on any sites around the world. For processes located in a specific region, the data used should be representative of the region. The data for the main components shall be the specific regional data for the region where the process takes place (see Section 9). For ease of comparison, no matter where the emissions are generated, the same parameters should be used for life cycle impact assessment (see Section 10).

6. Cut-off rules

For any impact category, if the sum of various impacts from a specific process/activity is less than 1% of the impact equivalent in that category, such a process/activity may be neglected during the inventory analysis. Components/parts and materials omitted from the LCA shall be documented.

(Note: This judgment for this “1% Rule” is based on the environment relevance assessment of material input to the system, and does not consider special and exceptional environmental impacts.)

7. Allocation rules

The main allocation rules shall be valid for the entire product system. For other secondary processes, other allocation rules may be defined; however, the use of these rules should be justified. Product-specific information should be preferentially collected in order to avoid the need for allocation.

While selecting allocation rules, the following principles are recommended.

- Multi-output: The allocations are based on the changes in the resource consumption and pollutant emissions (for example, adopted quantity allocation for some main component, or surface allocation for some components), following the changes in the studied system's output product or function or economical relationship.
- Multi-input: The allocation is based on actual relationship. For example, the manufacturing process's emissions may be affected by the change in waste flow input.
- Open loop recycling: For the input of recycled materials or energy during the manufacturing phase of the product system, the transportation between the recycling process and the recycling to material use shall be included in the dataset. For the product which shall be recycled during the manufacturing phase, the transportation towards the recycling process shall be included.

Notes:

- *Allocation may be avoided through avoidance of dividing processes, for example as described in Section 6.3 of ISO/TR 14049; or through expansion of system boundary (for example as described in Section 6.4), so that the amended system shares the same product exchanges as the original system.*

8. Units

The base units and derived units of the International System of Units (SI, *Système International d'unités*) shall be used preferentially.

The following units shall be used:

Power & energy units:

- power unit: W
- energy unit: J

Specification units:

- length unit: m
- capacity unit: m³
- area unit: m²
- weight unit: g

If necessary, prefixes may be used before the SI units.

10^9 = giga, symbol “G”
 10^6 = mega, symbol “M”
 10^3 = kilo, symbol “k”
 10^{-2} = centi, symbol “c”
 10^{-3} = milli, symbol “m”
 10^{-6} = micro, symbol “μ”
 10^{-9} = nano, symbol “n”

9. Calculation rules and data quality requirements)

- Site-specific data (for example, specific factory data or transportation data for a specific manufacturing process) shall be used for the manufacturing of chip/die and main materials, as well as optoelectronic semiconductor packaging/testing process. If other types of information are used, description of the information and rationale for using the information shall be provided.
- Generic data may be used for the raw materials acquisition and manufacturing processes. Generic data may also be used for the production of bulk materials (see Appendix I for sources of generic data). For example, when bulk raw materials are purchased from the spot market and during waste processing; when suppliers refuse to provide specific data; or when even if generic data are used in place of specific data, there is only minor impacts to the results. The general rule is that when generic data are used as substitute for site specific data, their combined contribution for all life cycle phases shall be no greater than 10% of the total impact for any impact category. But there may be certain exception to specific products.
- The data shall be representative for the average of a specific year.

Date quality requirements for the raw material acquisition phase:

- Generic data may be used in extraction and production of the raw materials used in product production.

Date quality requirements for the raw material manufacturing phase:

- Site-specific data shall be used for the production of chip/die and main materials.
- The electricity mix for the manufacturing phase should be site-specific data. If site-specific data cannot be obtained, the official electricity mix for the country where the site is located may be used as approximate value. The electricity mix should be documented.

- For the definition of hazardous waste, the definition as defined in Taiwan's Waste Disposal Act should be used for sites located in Taiwan. For sites located outside Taiwan, legal requirements for the host country shall be observed.

- For the transportation of raw materials, generic data may be used.

- For the transportation of chip/die and main materials from suppliers to the product manufacturers, the transportation modes and distances used by the suppliers shall be considered.

Date quality requirements for the optoelectronic semiconductor packaging/testing phase:

- Site-specific data shall be used for the optoelectronic semiconductor packaging/testing process.

- The electricity mix for the manufacturing phase should be site-specific data. If site-specific data cannot be obtained, the official electricity mix for the country where the site is located may be used as approximate value. The electricity mix should be documented.

- For the definition of hazardous waste, the definition as defined in Taiwan's Waste Disposal Act should be used for sites located in Taiwan. For sites located outside Taiwan, legal requirements for the host country shall be observed.

10. Parameters to be declared in the EPD

For the manufacturing phase, the following parameters shall be declared:

Energy Use MJ

Resource Use

- Use of non-renewable resources:
 - without energy content
 - with energy content
- Use of renewable resources:
 - without energy content
 - with energy content

Impact equivalents expressed as potential environmental impacts

-Global warming	kg CO ₂ equivalent
-Acidification	kg SO ₂ equivalent

-Ozone depletion	kg CFC-11 equivalent
-Photochemical oxidant formation	kg C ₂ H ₄ equivalent
-Eutrophication	kg PO ₄ ³⁻ equivalent

Note: For characterization factors of each impact category, please refer to *EPD Supporting Annexes*, Version 1.0 (2008-02-29), The International EPD Cooperation, downloadable from www.environdec.com.

Additional information

- Recyclable materials (optional)
- Information on secondary materials (optional)
- Waste (classification):
 - Hazardous waste as defined in Taiwan's Waste Disposal Act. Follow host countries' laws for sites outside Taiwan.
 - Other waste.

11. Recycling information

The recycling information shall include information such as disassembly instructions, which parts/components are suitable for recycling (such as metal cases) or not suitable for recycling.

Information for the parts which can not be recycled and therefore should be disposed of properly during the end-of-life phase may also be included.

12. Other environmental information (Optional)

The EPD may cover information including technology adopted, site of product manufacturing and assembly, as well as information on other working environment, health and risk-related aspects.

If this PCR is to be used for product carbon footprint declaration purpose, in the declaration, information regarding commitment on GHG reduction shall be included and shall ensure that the commitment is measurable, reportable and verifiable. The organization may also list environmental and energy management related information, such as awards, commendations and system certifications.

14. References

The EPD shall make reference to the following documents:

- EPD General Program Instructions, Version 1.0 (2008-02-29), The International EPD Cooperation, downloadable from <http://www.environdec.com/>.
- EPD Requirements, MSR 1999:2, downloadable from <http://www.environdec.com/>.
- Relevant PCR documents;
- The underlying LCA report.

When available, the following documents shall also be referenced:

- Other documents and recycling instructions which verify and complement the EPD.

Appendix I – Generic Data Sources to Refer to

For processes located within Taiwan, Taiwan generic data or the data published by the commercial, industrial and energy competent authorities of the Republic of China (ROC) government, may be used. However, for other regions (such as EU), if there are more relevant generic data available, these data should be used instead.

When data from the following generic databases are used, the most current and updated data should be used:

Material	Database	Published
Steel, Primary copper, Copper products, Electricity, Fuels, Aluminium, Chemicals, Transports, Waste management,	PE-GaBi	2006
	ELCD version 2.0	2009
	Ecoinvent 2 nd edition	2007
	The Boustead Model 5.0	2007
	EIME (Environmental Information and Management Explorer) EcoBilan	1998-2000
Plastics	PE Plastics Europe (Association of Plastics Manufacturers in Europe)	1993-1998
	PE-GaBi	2006
	ELCD	2009
	Ecoinvent 2 nd edition	2007
	The Boustead Model 5.0	2007
	EIME (Environmental Information and Management Explorer) EcoBilan	1998-2000
Electronic components	PE-GaBi	2006
	ELCD	2009
	Ecoinvent 2 nd edition	2007
	The Boustead Model 5.0	2007
	EIME (Environmental Information and Management Explorer) EcoBilan	1998-2000

Appendix II – Reporting Format for the EPD

This appendix provides guidance information for the titles of sections, types of data and required information to be reported in the mandatory reporting part of the EPD. As a generic reporting template, the following titles and sub-titles are recommended:

(Refer to the PCR manual for the section numbering, the information in Italics are the recommended data/information for inclusion)

Introductory part

Each EPD should have an introduction part on the top part of the EPD which includes the following information:

- *EPD system logo (LOGOTYPE)*
- *Company/organization name*
- *Product name*
- *EPD registration number*

Description of the company/organization and product/service

Company/Organization

- *Description of company/organization*
- *Description of overall working environment, existing quality system and environmental management system*

Product and services (see Section 2)

- *Product's main applications*
- *Description of product specification, manufacturing process, manufacturing sites (if there are several sites)*
- *For product's environmental performance aspects, characteristics which may improve the usefulness of product*
- *Other types of relevant information, for example, special manufacturing processes with special advantages to the environment*

List of materials and chemical substances

- *Content declaration (see Section 3)*

Presentation of the environmental performance

- *Outline of the LCA methodology, for example, period of LCA, declared units, system boundaries (graphical presentation), cut-off and allocation rules, and data sources.*

Manufacturing phase (see Section 10)

Information about Company and Certification Organization

Recycling information (see Section 11)

Other environmental information (see Section 12)

Information regarding certification

- *Names of certification and verification organizations*
- *Validity of certification certificates*
- *Compliance with legal and relevant requirements*

References (see Section 13)

- *relevant PCR documents*
- *EPD Requirements, MSR 1999:2*
- *underlying LCA study*
- *other supporting documents for LCA information*
- *other relevant documents regarding company/organization's environmental activities*

Appendix III Explanations of Terms

Chip/die: A piece of integrated circuit generated through cutting of wafer.

Packaging of semiconductor: A process using organic, metal or ceramic materials to package die/chip in order to form the semiconductor. The semiconductor packaging can protect the chip/die, as well as allowing the chip/die to be connected with external components/system.

Adhesive: Materials capable of gluing the raw materials together or providing electrical circuit connection, such as silver paste, epoxy or silicone etc.

Carrier Substrate: The support structuring capable of securing the chip/die, as well as rearranging the electrical circuit or facilitating external electrical connection, such as lead-frame (Cu/Fe), substrate (organic/ceramic, tapes, etc).

Electrical Connection: The parts which provide electrical connection between chip/die, carrier substrate, and external components, such as metal wire (Au), solder bump, solder ball, Cu pillar, Au bump, etc.

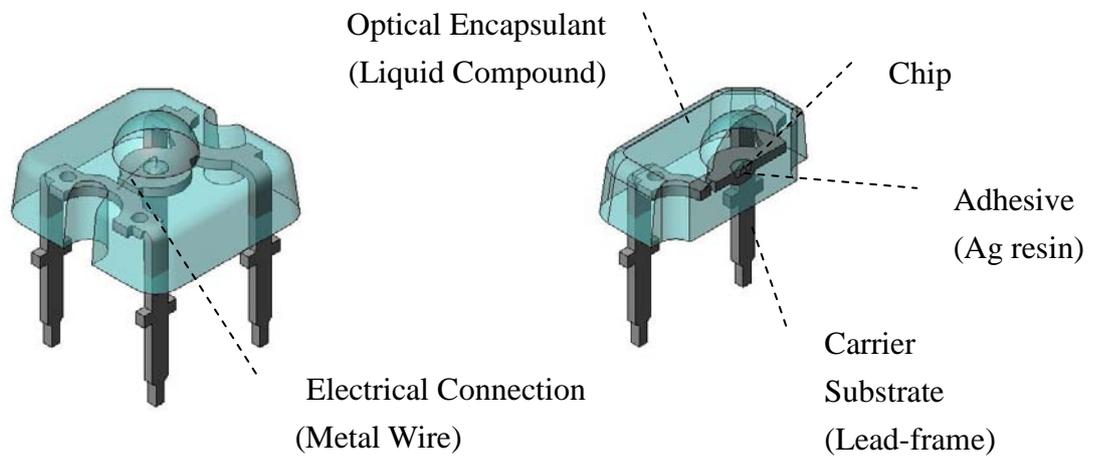
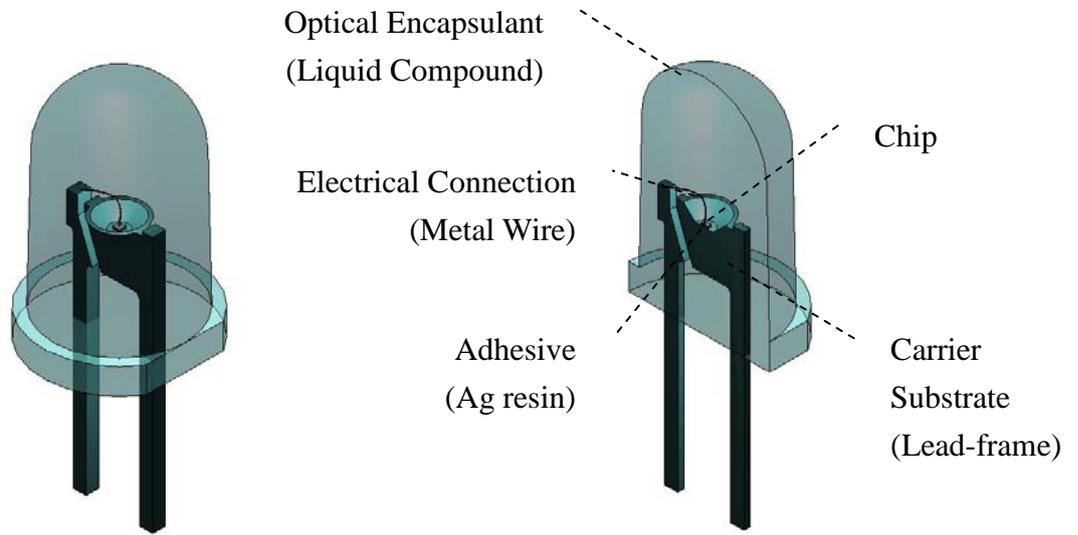
Optical Encapsulant: The parts capable of providing environmental protection (such as from moisture and contact) for materials and product, and modulating optical properties, such as molding compound, liquid compound, glass lens, etc.

Heat Dissipation: The parts which provide means of heat dissipation, such as heat sink/slug/spreader, TIM (thermal interface material), etc.

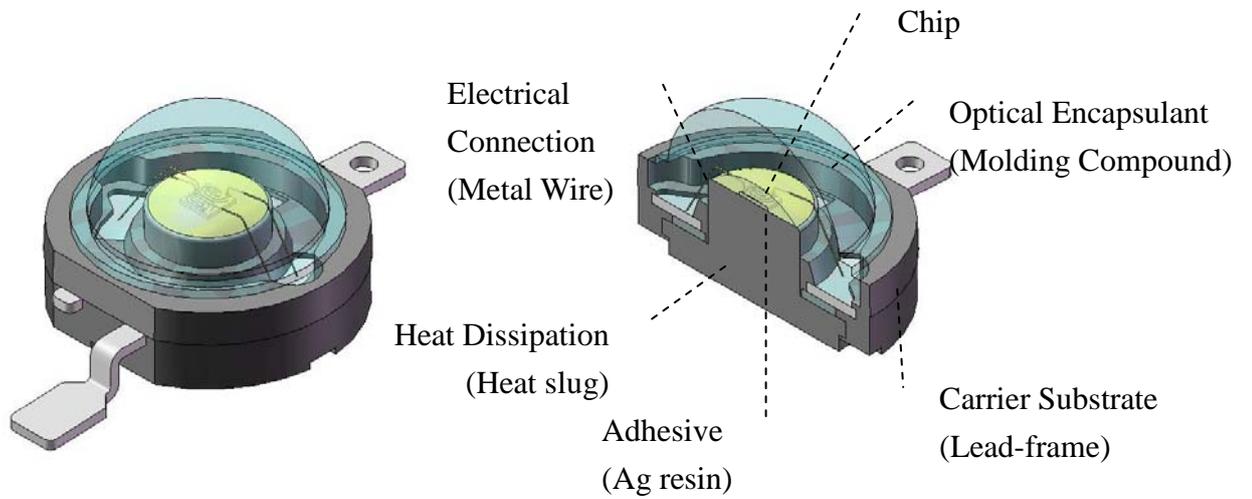
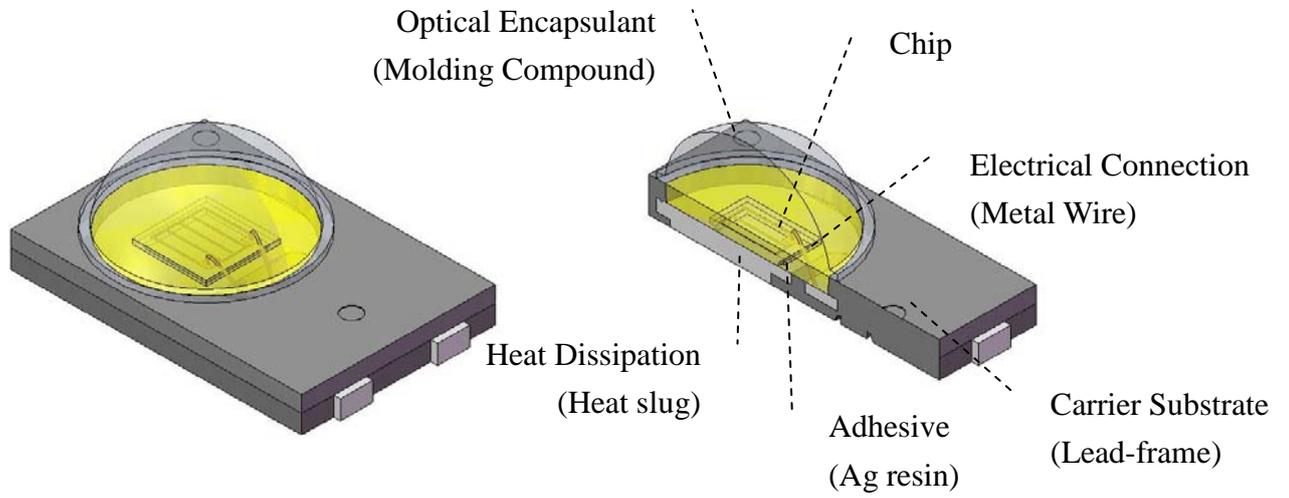
Packaging: The protective packaging materials used during product storage or transportation, such as bag, tape & reel, tray, tube, carrier, box, and other packing materials.

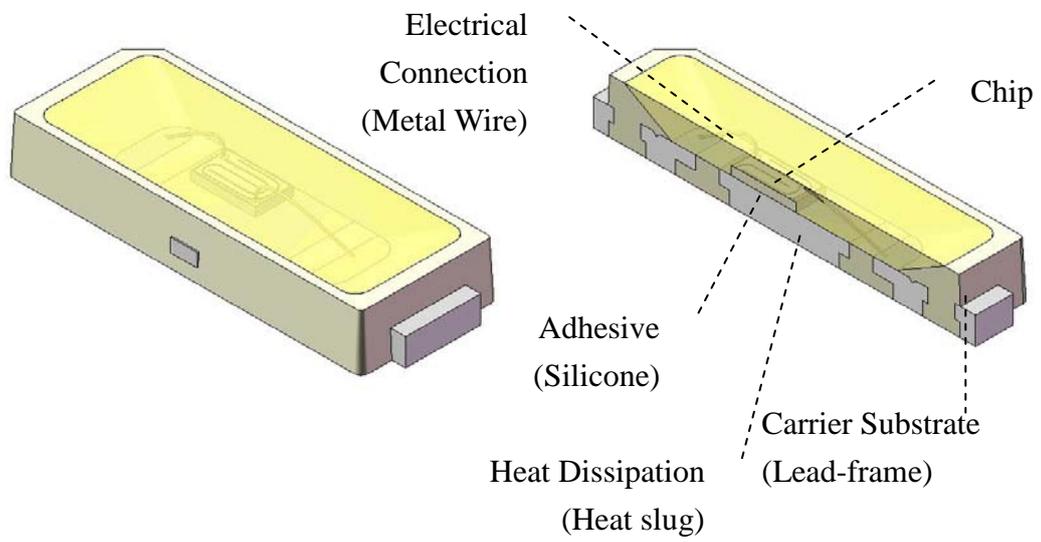
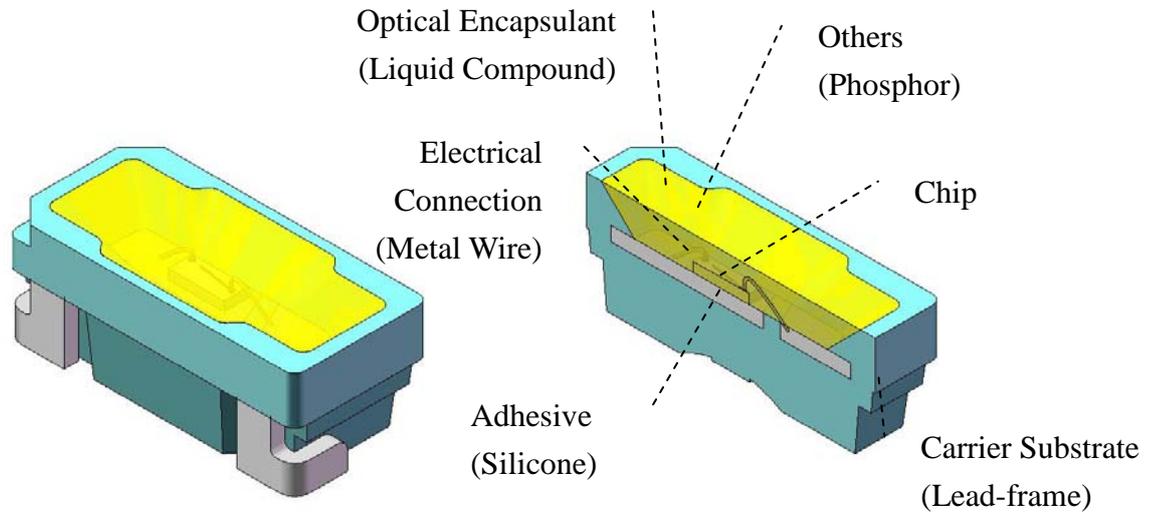
The schematic for the optoelectronic semiconductor covered in this PCR is presented such as below:

(1) Through hole LED

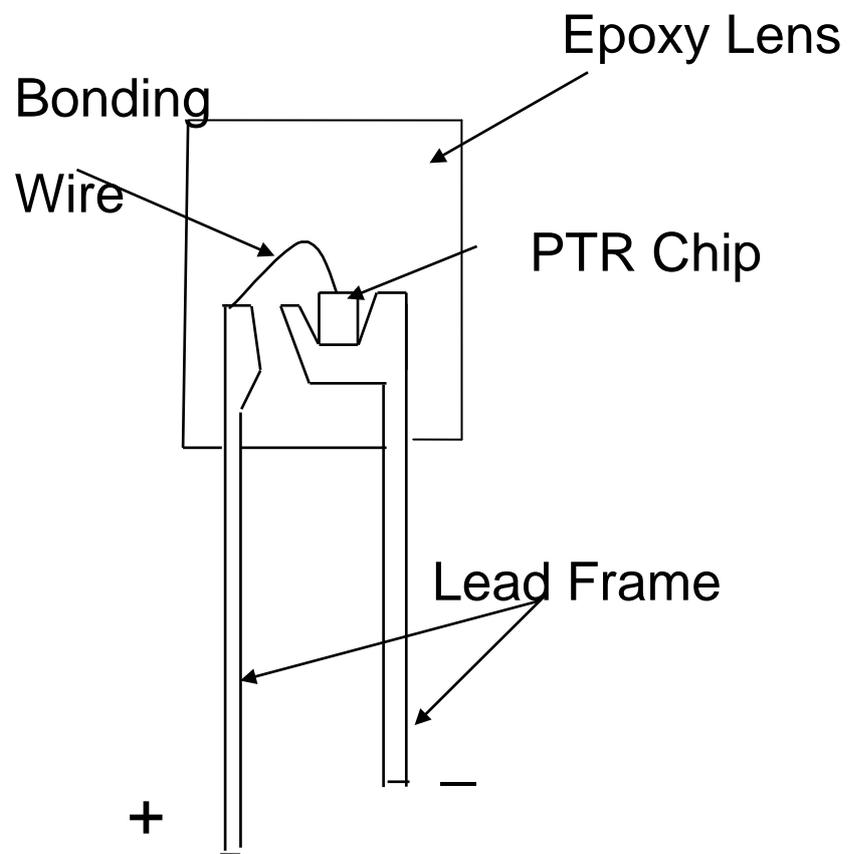


(2) SMD LED

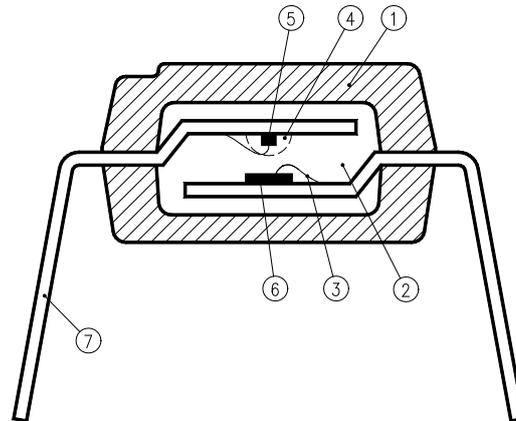




(3) Phototransistor



(4) Photocoupler



- 1: Black epoxy resin
- 2. Semitransparent epoxy resin
- 3. Gold wire
- 4. Transparent silicone resin
- 5. Infrared LED chip
- 6. Photodetector chip
- 7. Lead frame